Assessing a Wide Range of Instructional Goals for K-12 Teacher Professional Development

Amy D. Robertson, Sarah B. McKagan, Rachel E. Scherr, and Stamatis Vokos – Department of Physics, Seattle Pacific University

Energy Project (EP)

Research and *professional development* aimed at learning how best to teach energy in K-12 classrooms

Goals

Growth in K-12 teacher:

- Responsiveness
- Perception of science as flexible and constructed
- Perception of self as member of scientific community
- Energy-related pedagogical content knowledge

Growth along these dimensions is hard to assess, but we want to learn how to do it.

Teacher Responsiveness

What is it?

Noticing, interpreting, and responding to (or "taking up" student thinking as it arises during instruction.

Why do we value it?

Responsive teaching:

- Is aligned with a view of science as the "refinement of everyday thinking."[1, 2, 3]
- Distributes authority for assessment.[4]
- Is aligned with theory about how people learn.[2, 5]
- Is called for by current science education reforms.[6]
- Is correlated with student learning[5, 7, 8, 9, 10] and attitudes.[11]

How can we assess it?

Research questions

How do we assess teacher responsiveness?

How can we characterize/identify it?

What does the literature say?

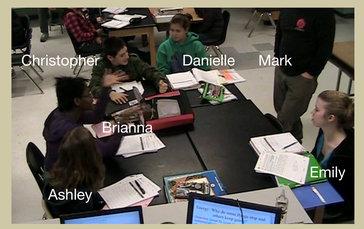
Is a synthesis of the literature sufficient to characterize all examples? Are there characteristics that are more central/prevalent than others?

Literature

Suggests that teacher responsiveness:

- Is selective.[12, 13]
- Puts student reasoning on display.[5, 14]
  - *Interprets* and *extends* (rather than *evaluates)* student thinking.[15, 16, 17]
  - Recognizes and responds to the "seeds of science" (mechanism and plausibility) in student reasoning.[1]
- Is connected to the discipline[18] (not relativist[1, 7]).
- Connects what is happening in the moment to next pedagogical moves.[15, 19]

An example of responsive teaching



- Mark's 8th grade classroom
- Beginning of iQWST[20] Energy unit

*Students on screen have been discussing whether a bus moving down the street **has** energy or **uses** energy.*

Mark put student reasoning on display by interpreting and extending student thinking.

Mark: So the bus has energy because it was.
Brianna: (Drops hands onto table) Well, does it have energy, or does it just use energy?
(Christopher puts hands on head and lowers head.)
Brianna: I mean, it's, it's a metal thing! [It's a thing! Metal.]
Christopher: [The bus has the energy to use energy.]
Emily: [But doesn't everything] like use energy?
Mark: (To student 3) What do you mean by that?
Christopher: When you just, like, press the pedal, the whole bus just, like, takes the gas, turns it into, like.
Brianna: Well it USES that energy [the gas has.]
Christopher: [So it uses YOUR energy] to make the bus move.
Mark: So are you saying the, the, like the gasoline is the energy?
Brianna: Yeah, the gasoline is the energy, and the bus USES the energy to power itself. Like, you know, the leaves use the wind to MOVE. And like we use, you know, whatever we have insides our bodies to FUNCtion and all that good stuff.

*In particular, Mark does not evaluate or judge student reasoning but "enters into the students' world,"[21] giving voice to meanings that are **implicit** (in addition to those that are explicit) in their thinking.*

(In fact, he came to our Teaching Seminar excited about this new idea he'd heard in his class – that students sometimes think of energy as a fuel.)

Mark coordinated student thinking with his next pedagogical moves.

Mark: So what if, so, go to like the, like the rolling ball. So we see a ball rolling, uh, on the ground. Does that, does that have energy?
Christopher: Energy, like, can't (roll?) on its own. Cause, like, you always, like, need to help it. And then, like, it goes (inaudible).
Mark: So aside from, like, we know that, like, I gave it a push. But forget that. Like (inaudible) we don't see anyone pushing it. We just see it rolling. Or let's say, let's just say we set a ball on a hill, and it starts rolling down the hill. Does that ball have energy?

Modified from:	→	*Modified to:*
Ball rolls after pushed.		Ball rolls down hill.

*In particular, Mark's adaptation of the scenario targets student question (or confusion) about whether or not a ball can **have** energy by taking away a visible **source** of energy.*

Mark put student reasoning on display by recognizing and responding to the mechanism in student thinking.

Brianna: …um, no, uh, I don't know, because I just want to say that, you know, it's...
Christopher: No, a ball on its own doesn't have, you're giving it energy.
Brianna: ...I just wanna say cause it's rolling down the hill because of gravity.
Mark: (Responding to student 3) What do you mean? I, but I'm just letting it roll downhill.
Brianna: Yeah, because of gravity.
Christopher: Yeah, but could I drop it?
Mark: Yeah, uh, a different scenario.
Brianna: You set it down.
Christopher: You set it down.
Brianna: And then I feel like gravity pulls it down.
Christopher: Yeah, so then there's like another force that helps it.
Brianna: But gravity is a type of energy.
Mark: So it's just, it's just forces, there's no energy involved?
Danielle: There's more than one source of energy helping it to move.
Christopher: Yeah, there's energy involved but it's not IN the ball.

Although Mark's students' response did not follow the trajectory he may have intended, he listened to and "picked out" the mechanism in their reasoning.

We have identified concrete examples of K-12 teacher responsiveness and are characterizing their features.

Next steps

In the near future:

- Continue to characterize episodes of responsive teaching (RT)
- Provide examples diversity in the quality of RT
- Determine if the existing literature sufficiently describes RT

On the distant, hoped-for horizon:

- Develop and disseminate ways of assessing RT
- Develop practice-based theory of how to teach RT

References

[1] D. Hammer and E. van Zee, *Seeing the Science in Children's Thinking* (2006).
[2] D. Hammer, *Student Inquiry in a Physics Class Discussion,* Cognition Instruct (1995).
[3] Learning Progressions Project (http://cipstrends.sdsu.edu/modules/modules/index.html).
[4] J. Coffey, D. Hammer, D. Levin, and T. Grant, *The Missing Disciplinary Substance of Formative Assessment,* J Res Sci Teach (2011).
[5] J. Pierson, *The Relationship Between Patterns of Classroom Discourse and Mathematics Learning* (2008).
[6] American Association for the Advancement of Science (http://www.project2061.org/events/meetings/textbook/literacy/cdrom/CRITERIA/6_3all.htm).
[7] G. Saxe, M. Gearhart, and M. Seltzer, *Relations between Classroom Practices and Student Learning in the Domain of Fractions,* Cognition Instruct (1999).
[8] N. Kersting, K. Givvin, F. Sotelo, and J. Stigler, *Teachers' Analyses of Classroom Video Predict Student Learning of Mathematics: Further Explorations of a Novel Measure of Teacher Knowledge,* J Teach Educ (2010).
[9] E. Fennema, T. Carpenter, M. Franke, L. Levi, V. Jacobs, and S. Empson, *A Longitudinal Study of Learning to Use Children's Thinking in Mathematics Instruction,* J Res Math Ed (1996).
[10] F. Goldberg, *Responsive Teaching and the Emergence of Energy Ideas in Third Grade Classrooms* (2012).
[11] T. Carpenter, E. Fennema, P. Peterson, C. Chiang, and M. Loef, *Using Knowledge of Children's Mathematics Thinking in Classroom Teaching: An Experimental Study,* Am Educ Res J (1989).
[12] F. Erickson, *On Noticing Teacher Noticing* (2011).
[13] K. Miller, *Situation Awareness in Teaching: What Educators Can Learn from Video-Based Research in Other Fields* (2011).
[14] A. Maskiewicz and V. Winters, *Interpreting Elementary Science Teacher Responsiveness Through Epistemological Framing* (2010).
[15] E. van Es, *A Framework for Learning to Notice Student Thinking* (2011).
[16] M. Sherin and E. van Es, *Using Video to Support Teachers' Ability to Notice Classroom Interactions,* J Tech Teach Ed (2005).
[17] M. Sherin and E. van Es, *Effects of Video Club Participation on Teachers' Professional Vision,* J Teach Educ (2009).
[18] D. Schifter, *Examining the Behavior of Operations: Noticing Early Algebraic Ideas* (2011).
[19] F. Erickson, *Some Thoughts on 'Proximal' Formative Assessment of Student Learning,* Yearbook Nat Soc Study Educ (2007).
[20] Investigating and Questioning Our World Through Science and Technology (http://www.umich.edu/~hiceweb/iqwst/index.html).
[21] C. Rogers, *On Becoming a Person: A Therapist's View of Psychotherapy* (1961).

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